hyaline, with a discal subapical transverse vein; posterior tibiæ with three spines.

Type, *R. cultellator*, Walk.

Remosa cultellator.

Dictyophora cultellator, Walk. List Hom., Suppl. p. 62 (1858).

Hab. St. Domingo.

Mr. Otto H. Sweezey, in his recently published 'A Preliminary Catalogue of the described Species of the Family Fulgoridæ of North America, north of Mexico,' has included the genus *Nonopsis*, Spin., in the Dictyopharinæ. Stål, however, to whom he gives a reference, placed it in the Tropiduchinæ, and Uhler also places it in the same subfamily. I have no personal knowledge of the genus.

LII.—*The Primary Septal Plan of the Rugosa.*

By R. G. Carruthers *.

[Plate IX.]

There has been of late years a revival of the long-dormant discussion as to the presence of four or six primary septa in the Rugosa. It would be, perhaps, as well to indicate briefly the reasons for the investigation of a point which may possibly seem of subordinate importance.

While most members of the Zoantharia have a hexamerous or dodecamerous primary plan, certain others, such as *Edwardsia*, have an eight-rayed arrangement. By common consent the latter is regarded as the more primitive type, and most zooids, whether hexamerous or not, are said to pass through an *Edwardsia* stage; in all cases, so far as it is known, the fundamental plan, when not of simultaneous formation, is arrived at by an insertion of bilateral pairs proceeding in a common order. It is a question whether this octamerous plan is genetically connected with that of the Rugosa, an extinct group of Palæozoic corals, commonly supposed to be primarily tetramerous, but whose other characters link them with the hexamerous Madreporaria; but the very slight amount of actual investigation of the early stages in these ancient corals has been a bar to their phylogenetic classification, and their relations to other Anthozoa have remained doubtful.

* Communicated by permission of the Director of H.M. Geological Survey.

When Kunth, in 1869 *, first clearly demonstrated the remarkable pinnate mode of septal development so characteristic of the Rugosa, in which new septa are added at four distinct points in the circumference of the corallum, he naturally inferred, in the absence of direct evidence, that these corals had four primary septa. But whenever actual investigation of the point has occurred, not four but six septa have been found. Thus Pourtales, in 1871 †, in the youngest stage he examined in *Lophophyllum proliferum* found six septa only, so symmetrically arranged that he regarded them as primary. It was not till 1902 that the matter was again taken up. In that year Duerden published an important paper ‡ in which Pourtales's conclusions with regard to *L. proliferum* were fully supported and in which an interesting relationship of the living Zoantheæ to the Rugosa is suggested; this paper also contains an excellent survey of the literature of the subject. In a later paper § the same author incidentally figures another instance where he has found six septa symmetrically arranged in the youngest stage examined in *Streptelasma rectum*, and which he regards as primary; and while preparing this manuscript for publication I have seen, through the kindness of Dr. Ashworth, an advance proof of a further note by Duerden ‖, in which he gives a list of five additional species in which six septa, presumably primary, have been observed.

On the other hand, it may fairly be said that no evidence has yet been brought forward conclusively demonstrating the presence of a primary four-rayed condition in these corals, though quite recently Gordon ¶, from examination of an Ordovician *Streptelasma*, has concluded that in that form there were four primary septa, and that of the six observed by Duerden in the Carboniferous *Lophophyllum* four were the true primary ones and the remaining two "accelerated secondary septa." It is hoped that in the course of the present paper it will be shown that Gordon's careful observations are in no way inconsistent with the presence of a

* Kunth, A., "Beit. zur Kennt. foss. Korallen," Zeit. d. Deut. Geol. Ges. xxi.

† Pourtales, L. F. de, "Deep-sea Corals," Illus. Cat. Mus. Comp. Zool. Harvard Coll. iv.

‡ Duerden, J., "Relationships of the Rugosa to the living Zoantheæ," Ann. & Mag. Nat. Hist. (7) ix.

§ Duerden, J., "The Fossula in Rugose Corals," Biol. Bull. vol. ix. no. 1 (1905).

‖ Duerden, J. E., "The Primary Septa in Rugose Corals," 'Science,' Aug. 24, 1906, p. 246.

¶ Gordon, C. E., "Early Stages in Palæozoic Corals," Amer. Journ. Sci. (4) xxi. (1906).

primary hexamerous plan in the Rugosa, but, on the contrary, support that view.

There seems to be no doubt that the unsatisfactory state of our knowledge of these primary stages is due to lack of sufficiently good material. There is, however, in the calcareous shales found in the Carboniferous Limestone Series of Scotland an abundance of small corals, chiefly Zaphrentids, and often beautifully preserved. Large numbers of these are in the collections of the Geological Survey, and in dealing with them during a revision of the corals for some forthcoming Sheet Explanations, so many were found to show the earliest stages of their septal development that opportunity was taken to investigate the matter further. The majority were so preserved that on carefully grinding down the tips, the septal arrangement could easily be seen with the aid of a hand-lens. This fact to some extent obviated recourse to microscopic sections, but of the latter about one hundred in all were made in order to permit of more detailed examination of the various stages. From the Museum of Practical Geology in London one or two additional Carboniferous corals and also several Silurian ones were obtained; while, owing to the kindness of Mrs. Gray, I have been able to examine from her unique collection of the Lower Palæozoic fauna of Girvan some small specimens of *Streptelasma* showing these early stages. They are from the Silurian (Llandovery) rocks of Woodhall Point and from the Ordovician (Llandeilo) beds of Craighead.

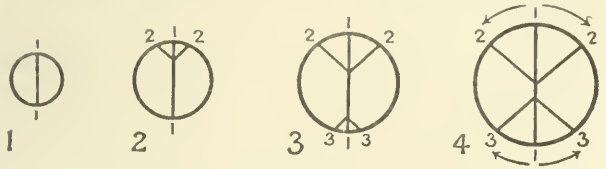
Sequence of Septa.

In all the corals examined the septa were found to appear in the same order and manner in both early and late Palæozoic forms. As an example, one of the small Carboniferous Zaphrentids will be chosen for description. The growth of the first six septa may conveniently be divided into three stages, but it is to be understood that these stages merge gradually into one another; it is not till all six septa have appeared that any pause in the development is met with. On carefully grinding down the tip of the coral the septal sequence is seen to be as depicted in Diagram A.

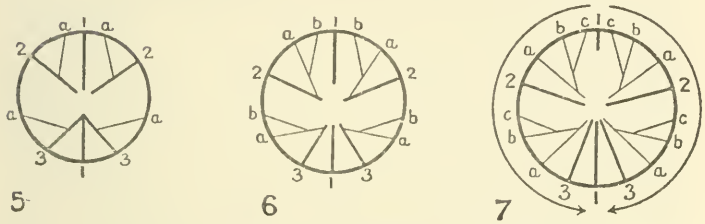
Stage I.—A single septum is seen to stretch across the calicle from wall to wall (diag. A. 1). This may conveniently be referred to as the "axial septum." In later stages this "axial septum" breaks up to form the main and counter septa of the mature coral. Microscopic sections show that the median dark line seen in most septa occurs here also in a continuous dark band passing down the centre (fig. 1, Pl. IX.).

Stage II.—Two new septa are next seen to arise, one on each side of the "main" end of the axial septum. Though remaining attached to the wall of the calicle and to the axial septum, they gradually spread outwards, and eventually form the "alar" primary septa of Kunth (diag. A. 2).

Diagram A.—Formation of Septa in a Simple Rugose Coral.



1–4. Development of the Primary or Protosepta.



5–7. Development of the Secondary or Metasepta.

Stage III.—Shortly after the alar primaries have developed another pair appears, in the same manner as before, but at the opposite or "counter" end of the axial septum (diag. A. 3). These also spread outwards, though very rarely to the same extent as the alar septa. There is now a distinct pause in the formation of new septa, and no more appear for some time. Any irregularity that there may have been previously in the growth of the septa is corrected at this stage, and the two lateral pairs dispose themselves symmetrically on each side of the axial line * (diag. A. 4). Later septa are added on a slightly different plan. As before, they appear at the junction of the last-formed septum with the wall and in pairs, but instead of moving towards each other as the two lateral primary pairs did, they all eventually move towards the counter septum, and all arise on the fossular faces of the last-formed septa (diag. A. 5, 6, & 7). No further description of the development of these later septa need be given here, as this part of the subject has been fully

* The six protosepta are rapidly developed. An opaque microscopic section (C. 55) shows very clearly the beginning of Stage II. on one side and the close of Stage III. on the other, although the section is less than ·5 mm. thick.

treated by previous observers, among whom Duerden should be specially mentioned.

The movements above referred to are in part shown by the varying angles of inclination of the septa to the axial line. These serve to express the fact that the first six or protosepta are developed differently from the later or "metasepta." The change is marked by the only developmental pause observed. In other words, the primary septal plan of these Rugose corals is hexamerous and is arrived at by an insertion of bilateral pairs analogous to that occurring in the soft parts of the rest of the Madreporaria and, indeed, in most Anthozoa.

There is commonly some irregularity in the growth of the two lateral protoseptal pairs, and in some cases an indication of a spiral, or, at any rate, an alternating arrangement. The direction of the spiral, however, was found to vary in different specimens of the same species, and may quite well be an irregularity of no special significance, such as commonly occurs in living corals. The important point is that this irregularity, when it occurs, is never so strongly marked as to interfere with the sequence above given—*i. e.*, the axial septum appears first, followed by the alar primary pair, and this by the counter lateral pair. Further consideration of this point may therefore be left to future investigation.

The septal sequence given above was originally observed in some varieties of *Zaphrentis Phillipsi*, Ed. & H., and has since been found in several other species enumerated below, together with the various stages found in each :—

Carboniferous	1. *Zaph. Phillipsi*, Ed. & H., and variants.	Stages I. to III.
	2. *Zaph.* sp.[1]	Stage III.
	3. *Lophophyllum eruca*, M'Coy.	Stages I. to III.
	4. *Cyathaxonia* sp.[2]	„ I. to III.
	5. *Dibunophyllum* sp.	Stage III.
	6. *Cyclophyllum fungites*, Flem.	„ III.
Silurian	7. (?) *Cyathophyllum*, sp.[3] (a Wenlock form).	Stages II. & III.
	8. *Streptelasma* sp. (a Llandovery form).	Stage III.
Ordovician ..	9. *Streptelasma* sp. (a Llandeilo form).	Stages I. to III.

[1] A small, long and narrow, tuberculated form, which I have been unable to specifically identify. It is labelled "*Pyrgia*" in the Jermyn Street collection—an obvious mistake. Reg. no. 16186 Mus. Pract. Geol. London.

[2] This is the form referred to *C. cornua*, de Kon., by James Thomson, and figured and described by him as such in Proc. Phil. Soc. Glasgow, vol. xiv. (1882–83) p. 428 and fig. 29, pl. x.

[3] Provisionally referred to this genus. It is certainly specifically distinct from the two species of "*Streptelasma*" examined from Mrs. Gray's collection. Reg. no. 16179 Mus. Pract. Geol. London.

The lower Palæozoic corals in the above list all had to be sectioned for the microscope before the early septa were visible. Consequently fewer specimens were examined than in the Carboniferous corals, of which nearly two hundred were obtained, showing Stages I. to III. But enough were obtained to show that these early Palæozoic forms agreed exactly in their initial stages with the Carboniferous ones, a conclusion of interest in view of Gordon's suggestion that there were four primary septa in the early Rugosa. But, using the length of the septa as a guide to their age, an examination of Gordon's own figure* of an Ordovician *Streptelasma* shows that it is in perfect accordance, from Stage I. onwards, with the septal sequence above described; the tendency to a spiral growth of the primaries is perhaps slightly more marked than usual, though this may well be an accident of preservation.

Except for *Dibunophyllum* and *Cyclophyllum*, all the corals examined were small forms. This is, of course, simply due to the fact that in large, heavy forms the delicate tip is more easily destroyed by rolling or movement of any kind.

In no instance have I found any essential divergence in the arrangement of the primary septa in the genera examined; and from the uniformity displayed in this respect, even in corals far removed in point of time, it seems reasonable to suppose that the sequence will be found to extend to the Rugosa as a whole, and that Duerden and Pourtales were right in considering these corals to be primarily hexamerous. Similar instances of the formation of the early septa in bilateral pairs have been observed in certain Mesozoic Hexacorallids †, but, indeed, the great majority of the Zoantharia seem to have a primary hexamerous plan, attained in most cases by the insertion of bilateral pairs. It is in the later stages that, as Duerden remarks, "divergences are introduced which are to be regarded as of the most fundamental importance in coral and actinian morphology."

While these results bring the Rugosa into closer association with modern corals and dismiss the idea that they are primarily tetramerous, and as such built on a more primitive basis than other Madreporaria, yet there are reasons to suppose that septal formation in these ancient corals took place

* *Loc. cit.* fig. 16, p. 120.

† See especially M. M. Ogilvie, "Microscopic and Systematic Study of Madreporarian Types of Corals," Phil Trans. clxxxvii. p. 291, diag. F & G (1896); and also pp. 97 & 105 of 'Die Korallen d. Stramberger Schichten,' Stuttgart, 1897 (by the same authoress).

in a more primitive way than that now existing; these considerations, however, I must defer to a future occasion.

The last point I wish to deal with concerns the orientation adopted for the figures in this paper. While in living corals the first six or twelve septa appear simultaneously, the entoceles in which they are formed arise in bilateral pairs, of which the first lateral pair appears on the dorsal surface. Similarly the dorso-lateral pair of exoceles arises before the ventro-lateral one. And again, the first six tentacles of most corals arise over the septa, and the dorso-lateral pair appears first. It would seem to be a general rule in the Zoantharia, indeed, that in the insertion of bilateral pairs of this nature the first appears on the dorsal surface. The natural conclusion is that in the Rugosa the first lateral pair of septa to appear, *i. e.* the alar septa (2 . 2), arose on the dorsal side of the corallum, and this whether the septa were exclusively entocelic or not.

It is only fair to Duerden to remark that the reverse orientation seen in his figures was adopted before the order was known in which the six primary septa of the Rugosa appeared.

Before concluding this paper I must express my hearty thanks to Dr. Ashworth, of the University of Edinburgh, for much valuable help, especially for the loan of papers not otherwise obtainable, and to Dr. Flett and Mr. T. C. Hall, of the Geological Survey, for the micro-photographs on Pl. IX.

EXPLANATION OF PLATE IX.

Horizontal sections illustrating the formation of early septa in Rugose corals. All figures have the "main," "cardinal," or "fossular" septum on the upperside, and with the exception of figs. 6*a* and 6*b* are from different specimens.

Figs. 1–6*b* from variants of *Zaph. Phillipsi*, Ed. & H.

Fig. 1. (C. 58.) Single septum of Stage I. × 40.

Fig. 2. (C. 67.) Appearance of the alar septa 2 . 2 in Stage II. The dark mark on the upperside is caused by earthy matter filling up the vacant space left by a "*Productus*" spine to which the young coral was attached—a very common phenomenon in these corals. × 35.

Fig. 3. (C. 90.) Early part of Stage III. The counter-lateral protosepta 3 . 3 just appearing. Irregular growth of septa. × 35.

Fig. 4. (C. 76.) End of Stage III. The six protosepta symmetrically arranged about the axial line. × 35.

Fig. 5. (C. 44.) Appearance of the first two metasceptal pairs (*a a*). The axial septum has broken up into "main" and "counter" septa (M and C). × 35.

Figs. 6*a* & 6*b*. Both from the same specimen. 6*a* (C. 68) shows

appearance of the two alar septa 2 . 2. 6 *b* (C. 69) is a later section and shows a pseudo-tetramerism caused by a late appearance of the two counter-lateral septa 3 . 3, and a divergence of the alar septa 2 . 2, most unusual at this stage. In the same specimen the main septum became detached before the addition of any metasepta. × 40.

Fig. 7. (C. 78.) *Cyathophyllum* (?). A Silurian specimen (Wenlock), to show the identity of the protoseptal arrangement of a Lower Palæozoic coral with that existing in a Carboniferous one. × 35.

The numbers in brackets refer to slides in the possession of the Geological Survey of Scotland.

LIII.—*Oriental* Reduviidæ. By W. L. Distant.

With the exception of one Bornean genus, the Reduviids described in this paper have reached my hands since the publication of the second volume of Indian Rhynchota ('Fauna of British India'). They will be included in the appendix to Vol. IV., now in preparation, and figures of the new genera will then be added.

Fam. Reduviidæ.

Subfam. *Emesinæ*.

Div. Stenolæmaria.

Ploiariola pygmæa, sp. n.

Head fuscous brown, the eyes black; antennæ creamy white with numerous fuscous spots or annulations; pronotum with the anterior lobe piceous, the posterior lobe fuscous, the former much irrorated with linear white markings and with its lateral margins ochraceous, the latter with its lateral margins and three central carinate lines (of which the central is incomplete and the two lateral meet anteriorly) creamy white, its posterior margin ochraceous; abdomen above fuscous, beneath greyish with fuscous spots; legs creamy white with fuscous spots or annulations; hemelytra creamy white with darker mottlings, on basal area the mottlings are fuscous and on costal margin there are fuscous spots; first joint of antennæ about as long as intermediate femora, second very little shorter than first; posterior femora about as long as whole body; anterior lobe of pronotum a little shorter than the posterior lobe, pronotal margins slightly sinuate.

Long. 3½ mm.

Hab. Ceylon; Peradeniya (*E. E. Green*).